Tatiana Canziani

Metaphor and Brain: A Neuropragmatic Overview

This article offers an overview of the different types of metaphor and cognitive abilities that are required in metaphor comprehension. It does so in connection with the general psycholinguistic and pragmatic theories of metaphor, which are examined briefly. Attention is then turned to neuropragmatic functions and the brain in terms of anatomic structure and functioning. Finally, the article suggests some relevant areas for future research.

1. *Cognitive Linguistics and Conceptual Metaphors*

Over the past few decades, research into cognition has revolutionized the concept and role of metaphor, which is no longer seen as a linguistic device but as a conceptual phenomenon, the output of a cognitive process by which we understand one domain in terms of another (Lakoff and Johnson 1980, 1999; Lakoff 1987, 1993).

Metaphors, which are the manifestation of one kind of conceptual structure, consist in sets of correspondences[1] between two do-

[1] Correspondences may be based on: 1) experiential conflation which derives from the conflation of subjective and sensory experiences (e.g., the subjective experience of affection is correlated with the physical experience of warmth) (Lakoff and Johnson 1999); 2) physical similarity or resemblance which focuses on the non-literal perception of shared features and takes place when the two domains share some features which

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mains or conceptual categories. More specifically, a metaphor is a mapping from a source domain (the conceptual domain from which we draw the metaphorical expression) to a target one (the conceptual domain that we try to understand). Given the cross domain-mapping and sets of correspondences, knowledge of the target domain may be used to understand and reason about the target domain in terms of the source (Ruiz de Mendoza and Otal 2002). In the words of Coulson (2006: 33), metaphors may be considered the "linguistic representation of underlying conceptual knowledge" based on our (ability to construe) experience, both personal and collective.

Within the field of cognitive linguistics, classic thought suggests that source domains come from our bodily experience and are based on perception, bodily movements, object manipulation, and patterns of forces acting upon and exerted by us (Fernandez-Duque and Johnson 1999). According to this view, human beings comprehend abstract ideas in terms of bodily experience (spatial movements and bodily function). This idea is supported by the seminal work of Lakoff and Johnson (1999) and Feldman (2006). In their neural theory of metaphor, Lakoff and Johnson suggest that human concepts are shaped by our bodies, brains and in particular by our sensorimotor system. An embodied concept then is a neural structure, which is actually part of the sensorimotor system of our brain since it makes use of the sensorimotor mechanisms of our body and arises from our bodily interactions with the world. Much conceptual inference is therefore sensorimotor and its locus is thought to be the same as that controlling perception and motor control associated with bodily functions (Lakoff and Johnson 1999).

In Cognitive Linguistics, many metaphors are grounded in the human perceptual system, which in turn is based on pre-conceptual, mostly spatial, configurations which allow humans to react to and to manipulate the world around them. As noted by Dirven and Ruiz de Mendoza (2010), such configurations, which were labelled by

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prompt the metaphoric mapping (Ruiz de Mendoza and Otal 2002); 3) structural similarity (or analogy) which is based on a structural alignment between the representational elements of the two domains (Gentner *et al.* 2001).

image schemas, allow us to categorize "phenomena in the physical domain and, by means of metaphor, phenomena in concrete domains are used to come to terms with experiences in the more abstract mental domains" (*ibid.*: 40). An image schema is an embodied multisensory pre-linguistic structure of experience since image refers not only to mental, visual imagery but also to kinesthetic (motor) imagery (Rohrer 2005). This structure seems to play an important role in metaphor comprehension because it links sensorimotor experience to conceptualization and language comprehension. As already observed by Rohrer (2005), in metaphor comprehension the image schemata of the source domain are mapped onto the target domain. By way of an example, in a metaphoric expression such as "I found this theory hard to grasp", the image schema of the source domain of object manipulation (grasping) is mapped onto the target domain of a mental activity (theory). The inference patterns of the source domain can be used to reason about the target. In terms of Cognitive Linguistics, we understand the meaning of "to grasp a theory" in exactly the same way that we understand what it means to grasp an object. This understanding of higher cognition (metaphor and language comprehension) as emergent from sensory and motor processes is supported by recent PET and fMRI studies of cognition (Gallese and Lakoff 2005). Our semantic understanding takes place via image schemata activating the same cortical areas activated during a sensorimotor activity. Sensory regions are, for example, active during the execution of action, but also during motor imagery (Matlock, Ramscar and Boroditsky 2005; Coulson 2008). These studies suggest that the neural substrate of metaphor comprehension depends on the particular source (e.g., colour concept or motion one) and target domains of the metaphor (Damasio *et al.* 1996).

Within Cognitive Linguistics, one common paradigm is based on the conviction that there is a fundamental unity and interaction among all cognitive faculties including perception, attention, categorization, conceptualization, affect, memory, reasoning and language (Dirven and Ruiz de Mendoza, 2010). In particular, this view has redefined the concept of metaphor by connecting it with cognition and by promoting the idea that language – including figurative language – contains categories and schemata that represent a cognitive model of the world (Smith 2008). Although metaphors may be analyzed from different perspectives,[2] in order to better comprehend the relation between cognition, brain and metaphor comprehension, in this paper we shall limit our analysis to metaphors based on analogical correspondences (structural similarity) since most metaphor studies in psychological and neurological literature refer to this kind of metaphor.

1.1. Theories about Metaphor Structure

"Many metaphors (perhaps most) are essentially analogies" (Gentner 1983:162) and they are presumably based on analogical reasoning[3] because we understand a new domain by comparing it with a situation already experienced in the past. So, comprehending a metaphor of the form an "A is a B" is based on the projection, through different domains or categories, of images, experiential inferences, and knowledge derived from experience and influenced by the culture we belong to.

The search for a coherent analogy between two conceptual domains seems to be activated by lexical categories. According to Glucksberg and colleagues (1997), metaphors, like comparisons, are interpreted as category-inclusion assertions by casting the topic and the vehicle into a common category. In property attribution terms, in order to make sense of a metaphor two kinds of knowledge are necessary: 1) a good knowledge of the topic together with its conceptual extensions; 2) a sufficient knowledge of the vehicle concept in order to identify the categories it exemplifies. According to this view, one may infer from a metaphor a category of things that the vehicle exemplifies so as to invest the topic with these properties. This category functions as an attributive one providing properties that may be ascribed to the topic (McGlone 1996). On the other hand, Gibbs

[2] For a detailed classification of metaphor types, see Ruiz de Mendoza and Otal (2002).

[3] Analogical reasoning is a kind of reasoning that applies between two specific exemplars, in which what is unknown about one exemplar is used to infer new information about another exemplar (Gentner 1983).

(1992) suggests that verbal metaphors are not simply instantiations of temporary, *ad hoc* categories but reflect pre-existing conceptual mappings in long-term memory that are metaphorically structured.

These analogical mappings seem to take place in specific mental spaces having specific roles. According to *blending theory* (Fauconnier and Turner 1998), metaphor comprehension (MC) is based on a sequential process activated through the creation of mental spaces which derive conceptual structure from frames representing the relationship between a topic and the vehicle. In the first phase, two mental spaces (the topic and the vehicle) are activated in order to find out the set of similarities between the source and target domains. In the second, the two input mental spaces are projected into a third one called the blended space, where all the information about the two domains is conceptually integrated into a single unit leading to the correct metaphoric meaning. The construction of these mental spaces is transitory as they are "small conceptual packets constructed as we think and talk, for purposes of local understanding and action" (*ibid.*: 137).

A more detailed description of analogical processing in cognitive and linguistic terms has been given by Gentner (1983). In his view, analogical processing in metaphor comprehension involves three main subprocesses: an analogical retrieval, which is the process of recalling a past situation from long term-memory; an analogical mapping, which is the core process in analogy and involves the selection and alignment of the correspondences between the two domains; a projection of inferences from the topic to the target and lastly the evaluation which consists in evaluating the analogical match and its inferences. These three analogical processes seem to be guided by the search for both conceptual (in terms of concepts and ideas) and linguistic (in terms of meanings) coherence.

One theoretical analysis of how an individual may arrive at conceptual and linguistic coherence in metaphor comprehension has been suggested by Relevance Theory (Wilson and Sperber 2004; Wilson and Carston 2006). Within this theoretical framework, metaphor comprehension is guided by the search for relevance, which is a basic principle of human communication and cognition.

In relevance-theoretic terms, any external perceptual stimulus or internal representation (thoughts, memories or conclusions of inferences) which provides an input to cognitive processes may be relevant to an individual at some time in metaphor comprehension when it connects with background information that yields a positive cognitive effect (true conclusion). Relevance is assessed in terms of cognitive effects and processing effort. The greater the processing effort required, the less relevant the input will be. Keeping processing costs low is automatic, since the human cognitive system has developed it in order to pick out potentially relevant stimuli from sensory and semantic memory as well as from inferential activity. Within this view, metaphor comprehension is an online goal-directed process where the main goal is to find an overall interpretation that satisfies the presumption of optimal relevance at the lowest processing cost. To achieve this goal a metaphor interpreter must enrich the decoded metaphor meaning at the explicit level (from the encoded concept to the *ad hoc* one) with tentative hypotheses by mutually adjusting concepts,[4] assigning reference, constructing a context and deriving contextual implications (conclusions deducible from the input and context together).

The theories briefly outlined above seem to share the idea that the central feature of metaphor comprehension of the simple form "A is B" is analogical reasoning – a process through which a set of analogical correspondences between two domains are created and integrated in order to achieve linguistic and conceptual coherence. The important role of analogical reasoning is supported by recent research that has found a relationship between analogical reasoning and ratings of metaphor aptness. Trick and Katz (1996) have observed that subjects with higher analogical reasoning scores give higher ratings to metaphors whose terms come from dissimilar domains and are more sensitive to the precise structural correspondences between domains. But not all metaphors are alike. Therefore, before introducing the different cognitive and extra-linguistic factors

[4] Within this process a central role seems to be played by lexical narrowing and broadening that combining give rise to a range of lexicalized senses that yield to an adjusted concept or linguistic meaning.

involved in metaphor comprehension, it is necessary to briefly classify the different types of metaphors.

2. *Conventional and Novel Metaphors*

Metaphors may be classified in many ways but generally they are considered to be either conventional or novel according to two parameters: 1) the frequency of their use in everyday language; 2) their level of familiarity in terms of meaning.

A metaphor is conventional when it is so familiar that it has become part of our everyday language (e.g. LIFE IS A WAR). Its comprehension does not require a supplementary cognitive effort because its figurative meaning is an extension of its original literal one. On the other hand, a metaphor is novel when it conveys new, unfamiliar meaning. Within this category there are metaphors that have been created *ad hoc* in order to define new concepts. Their comprehension seems to require additional cognitive effort, which is necessary to understand the set of ontological correspondences used to create a link between its significant and its meaning (Blasko and Connine 1993). As already observed by McGlone (1996), understanding novel metaphors may take more time because one must infer the attributive category that the vehicle exemplifies.

2.1 Cognition Required for Metaphor Comprehension and Contextual Linguistic Factors

According to some theorists, in processing a metaphor of the form "A is B" such as LAWYERS ARE SHARKS without any contextual information, any normal individual would follow the following cognitive steps:

1) recognize that this sentence cannot be read literally;
2) transform the sentence, from a syntactic point of view, into a simile such as "Lawyers are like sharks" relating the two domains.

These two steps are widely supported by scholars such as Ortony (1979), Gentner (1983) and Miller (1991), who suggest that metaphors are first recognized as false assertions and then transformed into comparison assertions.

3) Identify the similarities between the source domain (sharks) and the target one (lawyers) by retrieving all information about the two domains from his/her long-term memory as pointed out by the attributive categorization view.[5] This step involves different sub-processes. First of all, working memory (WM) is activated so as to retrieve from long-term memory shark attributes (predator, good swimmer, aggressive, tenacious, living in the oceans, having fins). Within this phase a mental image of the unknown domain (in this case shark) whose mental image is personal may be retrieved from long-term memory. As already observed by Paivio (1971), mental image retrieval may contribute to comprehending a linguistic stimulus since it helps an individual to find out information about the vehicle that concrete words cannot give.

Finally, the attributes of the metaphor vehicle (shark) that are not appropriate are suppressed, as suggested by Giora (1997), Gernsbacher and Robertson (1999). According to Coulson and Oakley (2005), in this phase memory plays a central role since the recruitment of a large stock of background knowledge is necessary in order to find out all the candidate attributes.

4) Project and adapt the selected qualities (aggressive and tenacious) of the source domain to the target one (lawyer's behaviour when defending a client) as proposed by conceptual blending theory (Fauconnier and Turner 1998). In this final phase, all the information about the domains lead to the correct metaphoric interpretation (lawyers are as aggressive and tenacious as sharks).

On a cognitive level, the search for an analogy between two different domains which share a common concept seems to involve the activation of different cognitive abilities. For any given metaphor, comprehension may depend on a multitude of factors, including the type of metaphor, the sentence context, the distance of the semantic task, the demands of the task, the verbal ability of the individual, the

[5] The term "attributive" category refers to the view by Glucksberg *et al.* (1997) in which they consider that metaphors of the form A is B may be conceived as statements of property attributions (that is, both topic and vehicle may belong to the same category and may be considered as having the same attributes).

working memory (WM) capacity. Moreover, metaphor comprehension is highly sensitive to extra-linguistic factors such as the amount of contextual information, the situation where the metaphor occurs, the listener's culture (social/cultural level) and his/her experience of life. The linguistic experience of the individual over time sets up a semantic network structure that flexibly interacts with contextual information which may be nonverbal, such as gestures (Cornejo *et al.* 2009), but also linguistic, such as a sentence preceded by either short or long contextual information[6] (Inhoff *et al.* 1984). Such information facilitates the understanding of abstract expressions such as those involved in novel metaphors.

Recent neuropragmatic studies on the topic (Kintsch 2000; Kazmersky *et al.* 2003; Chiappe and Chiappe 2007) show that the quality of metaphor comprehension may be influenced by at least four cognitive capacities: IQ level, working memory capacity, abstract thinking and mental imagery. In the following sections, we shall examine the literature regarding the role of these four cognitive capacities in metaphor comprehension. The role of IQ and WM will be considered in section 2.2 while abstraction and mental imagery will be dealt with in 2.3.

2.2 "Metaphoric" Cognitive Abilities: IQ and Memory

A few studies have shown the correlation between metaphor comprehension and different individual cognitive abilities. One source of individual differences in metaphor processing may be linked to a person's skill in bridging the semantic domains of a topic and its vehicle,[7] as observed by Kazmersky *et al.* (2003). These authors suggest that a fundamental cognitive factor in metaphor comprehension is the IQ level of individuals. In their opinion, low-IQ subjects may be capable of understanding conventional metaphors but they may differ on the quality of their interpretations – a possible explanation could be that they have a smaller vocabulary net-

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[6] Ortony and colleagues (1978) showed that comprehending metaphoric sentences in a short context took significantly less time than in a longer context.

[7] This ability seems to arise in individuals from the age of 7-8 years old and gradually increases with his/her age and progress in school (Nikolaenko 2001).

work as well as a reduced WM capacity leading to less automatic activation of metaphors. Moreover, the authors suppose that their ability to interpret a metaphor may also depend on the task demands. Low-IQ subjects will have more difficulty in understanding metaphors if the task is speeded and/or if it involves not just judging whether a sentence is metaphoric but also verbally explaining why and how it is metaphoric.

Another important cognitive factor in metaphor comprehension is WM (Kintsch 2000; Chiappe and Chiappe 2007). As already observed by Cohen *et al.* (1997), WM is responsible for the short-term storage and online manipulation of information necessary for higher cognitive functions such as language, problem solving and comparison operations. Moreover, according to Baddley's (2003) multimodal model, WM has different executive functions such as directing attention to relevant information (suppressing what is irrelevant), coordinating cognitive processes when more than one task is required, constructing and manipulating visual images as well as the supervision of information integration. Recent research (Blasko 1999; Kintsch 2000; Chiappe and Chiappe 2007) has shown that individual differences in WM capacity and its executive functions may affect metaphor comprehension. These studies lead us to believe that high-WM individuals may produce better interpretations of novel metaphors in terms of quality and speed than low-WM ones. This empirical fact squares well with the way mental spaces are argued to be operational since they are "knowledge packets, derived from our long-term knowledge store (Long-Term Memory), and used provisionally and in combination with other mental spaces for the purpose of performing certain cognitive operations" (Ruiz de Mendoza and Santibáñez 2003: 294) which take place in our WM. Indeed, as already observed by Coulson and Matlock (2001), metaphor comprehension requires coordinating conceptual structure in order to apprehend the set of correspondences between two domains involving the construction of a blended space in which structure from each of these inputs can be integrated. The blended space inherits goals of the two domains and the inference arises when these structures are integrated to create a hypothetical structure with both characteristics. They suggest that integration involves three processes: 1) composition (attribution of a relation from one space to other elements from the other input spaces); 2) completion, which occurs when structure in the blend matches information from Long-Term Memory; 3) elaboration, which involves mental simulation of the event represented in the blend (for example, in visual imagery, the comprehender mentally imagines the scene). These assumptions seem to suggest that mental spaces are the blending theory of WM in Psychology, since blending appeals to a conceptual integration network where WM seems to play a central role in metaphor comprehension. So, individual differences in IQ level and WM capacity may provide functional limitations in terms of speed and efficiency in metaphor comprehension. Unfortunately, there have been few studies that have concentrated on the role of the different WM executive functions in metaphor comprehension.

2.3 Abstraction and Mental Imagery

Another fundamental factor in metaphor comprehension is abstraction. Kircher *et al.* (2007) define abstract thinking as the human ability to think beyond the concrete facts or rather to go beyond the literal meaning of the words. Yang *et al.* (2010) claim that in metaphor comprehension abstract thought refers to: 1) the executive control processes necessary to detect multiple possible semantic interpretations of a linguistic statement; 2) the ability to override a literal meaning in favour of a broader symbolic one. In line with these assumptions, the ability to abstract concepts in metaphor comprehension means the capability: 1) to recognize instantly that a sentence is not meant to be taken literally but metaphorically; 2) to identify the similarities between the source and target domains; 3) to isolate the partial quality of the object-source after retrieving from our memory the chains of abstraction or the different constituents of our semantic abstraction. Therefore, mental imagery reflects figurative understanding and the individual's tacit awareness of underlying metaphoric concepts, and develops with age (Duthie *et al.* 2008).

Another important cognitive factor involved in this process is the reproduction of a mental image while processing a metaphor. In psychology, a mental image is usually described as being associated with a word within our long-term memory. Considering, for example, the word "tree", even if this semantic category may include different types of tree such as the bald cypress, the oak tree, and the pine tree, a personal image of the word "tree" may be represented by only one of these types of tree (e.g. the pine). Moreover, memory registers it with its multisensory components (visual, olfactive, tactile, gustatory) as well as other features such as the shape and the location (related situational event). This image is personal because it is directly linked to episodic memory, which represents our knowledge of the world built up on the grounds of everyday experience. Kosslyn and colleagues (1995) suggest that mental images are a fundamental part of human thought and play a central role in abstract thinking and language comprehension. They affirm that people often use imagery to recall information when processing a linguistic stimulus since mental images have perceptual properties that verbal material has not. According to them, imagery can help one to better comprehend verbal descriptions. So, following these assumptions we may suppose that imagery, with its perceptual properties, works in concert with verbal knowledge in order to process vehicles that cannot easily be inferred from verbal material.

3. *Neuropragmatics and Hemispheric Involvement in Metaphor Comprehension Processing*

Neuropragmatics deals with how the brain comprehends and produces verbal pragmatic behaviour or rather how an individual makes choices and inferences in order to convey a specific meaning in a particular context (Stemmer 2000; Bertuccelli Papi and Baicchi 2008). Following Bambini (2010), the main goals of neuropragmatics are: 1) to examine "how brain represents beliefs, knowledge and components of context in order to infer speaker's meanings and to engage in successful communication" (*ibid.*: 2) since the communicative use of language (in terms of production and comprehension) is deeply influenced by our knowledge, beliefs, mental and emotional states; 2) to investigate the underlying neural basis of our pragmatic abilities such as perceiving and filtering information, integrating incoming linguistic stimuli with a precise goal, planning and monitoring behaviour (e.g., appreciating another person's thoughts and beliefs), providing coherent feedback in terms of concepts and meanings. So, the goal of neuropragmatics is to better understand the functional architecture of the brain networks activated by specific pragmatic behaviour and processes (e.g., figurative language and humour comprehension and production).

Within neuropragmatics studies on metaphor comprehension there are two main approaches, the experimental and the clinical one. The former concentrates on studies conducted on healthy subjects (e.g., Eviatar and Just 2006; Rapp *et al.* 2004; Mashal *et al.* 2007) while the latter concentrates on studies conducted on diseased subjects (e.g., Gagnon *et al.* 2003; Kircher *et al.* 2007; Nikolaenko 2001). Both approaches use imaging techniques and/or Event-Related Potentials (ERPs). These techniques give information about the brain regions and the strength of their interconnections during a cognitive performance task. They have a low-temporal resolution because they aggregate brain activity over a few seconds, whereas ERPs possess a high-temporal resolution and provide a continuous temporal measure of the electric neural brain activity during the task. In particular, the amplitude of N400 wave seems to play an important role in identifying the semantic integration process. This negative voltage deflection has been found to be larger in cases in which semantic integration is more difficult (Coulson 2006).

Early research in metaphor comprehension supported the selective role of the Right Hemisphere (RH) in this process. The RH was assumed to have a selective and significant role in controlling pragmatics and specific forms of language such as jokes, metaphors, indirect requests, irony and lexical ambiguity. RH recruitment in metaphor comprehension has been explained in two ways: Giora's Gradient Salient Hypothesis (GSH) and Beeman's Coarse Semantic coding. Giora (1997) suggested that RH involvement may vary as a function of familiarity with the linguistic stimuli. In her view, the comprehension of figurative and literal language is governed by the general principle of salience. The degree of meaning salience of a linguistic stimulus is based on its conventionality, experiential familiarity, frequency and prototypicality. Highly salient metaphors (conventional) have unconditional priority over less salient ones. They are directly coded in the mental lexicon and are easily accessed. By contrast, non-salient meanings such as those of novel metaphors are not coded in the mental lexicon because their meaning is unfamiliar. The GSH predicts a selective RH involvement in the processing of novel metaphors having non-salient meanings, and a LH involvement in the processing of conventional metaphors having salient meanings (Rapp *et al.* 2004).

In contrast, Beeman's (1998) semantic coding model suggested that in metaphor comprehension each hemisphere activates semantic information differently. The LH is concerned with the fine-coding of semantic information by selectively and strongly activating small semantic fields for understanding more frequent or contextually relevant meaning (conventional metaphor), whereas the RH coarsely codes semantic information diffusely activating distant semantic fields. These studies suggest that when people successfully integrate very distant associations the RH temporal areas are deeply involved. So, RH coarse semantic coding is useful for noting and integrating distantly related semantic information (novel metaphors).[8] But because "the RH is poor at selecting information for further processing, it is the LH that selects inferences and incorporates them" (Beeman 1998: 279). Thus, both hemispheres turn out to be engaged in semantic processing, but they do so differently (Arzouan *et al.* 2007). RH involvement seems to be highly correlated with novel metaphors, whereas LH involvement seems to be highly correlated with conventional ones. However, the exact functional organization of these hemispheres still remains unclear.

[8] In particular, it seems that the right Post Superior Temporal Sulcus (PSTS) plays a special role in the comprehension of novel metaphors since it recruits a special network which is involved in the processing of two-word novel metaphoric expressions as compared to conventional metaphors. This region, in fact, is activated when subjects solve creative problems especially with insight (Beeman 1998).

3.1 Brain Areas and Metaphor Comprehension

Many studies of metaphor processing have focused on investigating hemispheric lateralization and novelty effects during interpretation of novel or unusual metaphors (Yang *et al.* 2009). According to Beeman (1998) and Giora (1997), the LH is activated if high salient meanings or close semantic relationships are processed; by contrast, RH is activated if distant semantic relationships and low-familiar meanings are processed. Other studies disagree with this theory suggesting that when an individual processes a metaphor (both conventional and novel) it seems that both hemispheres work in concert in a complex and dynamic process (Arzouan *et al.* 2007).

These contradictory findings may be due to differences in the linguistic stimuli and task demands used in the various studies. Most of the studies concentrate on comparing conventional versus novel metaphors but the linguistic stimuli used in the various experiments present different degrees of complexity and determine different hemispheric involvement (for a detailed meta-analysis on this issue, see Kacinik and Chiarello 2007).

According to Gagnon *et al.* (2003), RH involvement in metaphor comprehension could depend on syntactic complexity more than on novelty. The use of a complex expression such as "The policeman who didn't give straight answers was jumping ditches" (Rapp *et al.* 2004: 399) may activate brain regions involved in complex syntactic processing – on a sentence level – which are not activated when processing simple metaphoric sentences such as "my alarm clock is a torture" (*ibid.*: 399). Moreover, besides different brain area activations,[9] processing single metaphoric meanings may reflect different cognitive abilities than those involved in processing simple or complex metaphorical sentences (Gagnon *et al.* 2003).

A further factor which may bring about different results is the type of demands (semantic judgments, plausibility judgments, imageability tasks, valence tasks). A valence task,[10] for example, will

[9] Within the RH, the gyri involved in complex syntactic processing seem to be the right superior and middle temporal gyri (Gagnon *et al.* 2003).

[10] In a valence task participants are asked to give to the item a positive or negative connotation.

involve paralinguistic factors, such as social information which is not required when performing an imageability task.

Recent neuroimaging literature points out that laterality and neural activation in metaphor processing may be influenced by task instructions. Moreover, metaphor comprehension is highly sensitive to the context as previously observed. For example, in a conversational context, body expressions, speaker's gestures and facial expressions may influence comprehension. Contextual features like these may be part of the global sense of metaphoric expressions and they require the ability to interpret the speaker's intentionality as well as the integration of gestural information. Finally, statistical samples are almost always composed of a small number of participants and they are heterogeneous in terms of age and language spoken. As a consequence of these methodological difficulties, establishing a direct and precise correspondence between metaphor processing and brain area activations is quite difficult because of the heterogeneity of the previous studies and the techniques employed.

3.2 Brain Areas and Language Functions

Basic language functions, such as processing and production, are normally associated with the LH. Within the LH, the anterior part controls phonology and syntax and the posterior part controls semantics (Soroker 2005). In particular, the Left Inferior Frontal Gyrus (LIFG) seems to support multiple functions such as the processing of varying word orders, semantic and phonological processing as well as semantic selection, thus allowing comprehenders to select concepts in order to build up their mental representation of natural language input (Beeman 1998). The thalamus may serve as a moderator that coordinates language processing with other regions since its pulvinar is connected to the language-relevant areas of the cortex (parietal, temporal, occipital and frontal cortex). The RH, on the contrary, seems to have a selective role in controlling pragmatics, speech prosody, and metaphor, as well as in the control of humour (Soroker 2005).

As far as interhemispheric communication is concerned, the corpus callosum (see figure 1) seems to play a crucial role in metaphor comprehension. Recent studies have demonstrated that patients with agenesis of the corpus callosum have a deficit in understanding conventional metaphors and emotional prosody (Eviatar and Just 2006). These authors suggest that such patients have difficulty in transferring complex information from one hemisphere to the other probably because this brain region has the main function of connecting the two hemispheres and sharing information through it.

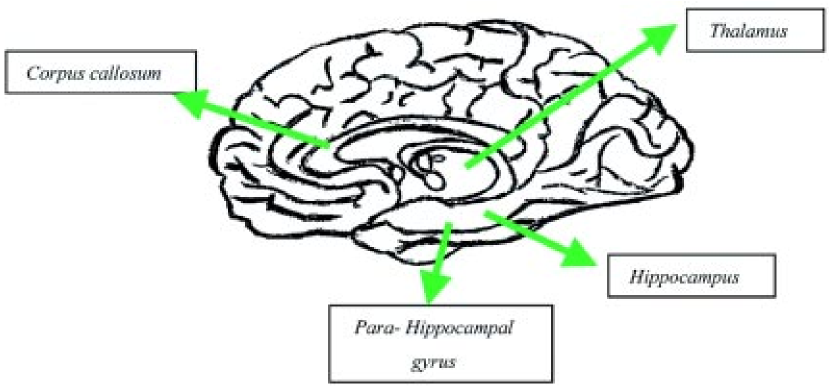

Figure 1 – Anatomic region of the brain concerned with speech and thought

3.3 Brain Areas: Memory

As far as memory is concerned it seems that the hippocampal system is responsible for retrieval of episodic memory. A bilateral hippocampal lesion determines an inability to deposit information elaborated in the WM into long-term memory. The left prefrontal cortex, in particular the dorsal part, seems to play an important role in the maintenance of information in WM. Moreover, activations in the left prefrontal cortex reflect a domain-specific semantic WM capacity when an individual makes a semantic judgment (concrete vs. abstract) while left posterior parts are involved in phonological WM.

The RH, on the contrary, seems to be deeply involved in carrying out difficult processes such as distant semantic meanings and mental images which are difficult to reproduce or when retrieving and elaborating paralinguistic information as well as in specific WM tasks. In particular, within the RH, the right thalamus is recruited when processing novel metaphors which are difficult to understand; the right para-hippocampal region reflects the processing of paralinguistic elements such as the retrieval of social information necessary in valence tasks; the right prefrontal cortex is, on the contrary, involved in spatial WM.

3.4 Analogical Reasoning: Abstract Thinking and Reasoning

Recent research in this field seems to demonstrate that, as far as abstract thinking is concerned, two main brain areas may be involved in this process: the LIFG and the angular gyrus (see figure 2). A study was conducted on schizophrenic patients who normally have a specific figurative language deficit probably linked to an inability of abstract thinking (Kircher *et al.* 2007). These patients are prone to over-abstract concepts giving interpretations which are detached from reality. This dysfunction is due to an altered activation in the inferior frontal gyrus. It seems that one of the specific roles of the LIFG could be to perform selection in the face of competing words as supported by recent studies which observed LIFG activation when one of the multiple meanings of an ambiguous word can be ultimately selected and integrated (Grindrod *et al.* 2008).

A second gyrus which seems to be deeply involved in metaphorical abstract thinking is the angular one. Right-handed patients with left angular gyrus damage were found to have gross deficits in understanding even familiar metaphors (Ramachadram and Hubbard 2003). The abstractness of metaphors escaped them completely since they gave responses that were literal rather than metaphoric. Ramachadram and Hubbard (2003) offered an explanation, suggesting that this region is a seat of polymodal convergence of sensory information because it is at the crossroads of areas specialized for processing sensory inputs (touch, hearing and vision). It seems then that the LIFG and the angular gyrus play a crucial role in forming abstract concepts in metaphor comprehension.

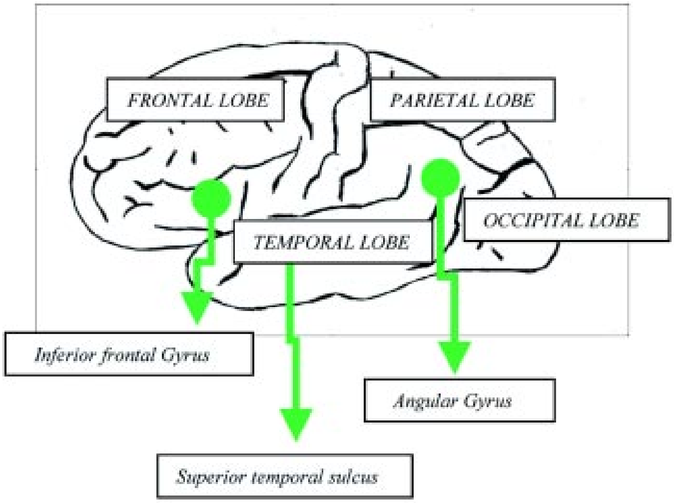

Figure 2 – Anatomic regions of the brain involved in metaphor comprehension

3.5 Mental Imagery

Forming a mental image when processing a conventional metaphor activates specific brain regions different from those activated when processing a novel metaphor (Yang *et al. 2009*). In their study Yang *et al.* (2009) asked participants to form a mental image of a conventional or novel metaphoric sentence and to figure out what the sentence meant while they measured different areas of the brain using fMRI techniques. Their data support the idea that conventional metaphors consistently recruited the left middle temporal gyrus, the right fusiform and the temporal and inferior frontal gyri. They suggest that the left middle temporal gyrus is involved when forming a mental image of a learned metaphor (concrete); on the contrary, the right fusiform is related to the integration of visual and semantic information.

Novel metaphors, on the other hand, consistently activated the left fusiform gyrus and the right precuneus. An increased activation in the right precuneus probably reflects the difficulty in forming a mental image when processing abstract concepts and novel metaphors as well as the reinstatement of visual images associated with remembered words (Fletcher *et al.* 1995). Thus, the right precuneus is probably responsible for the retrieval of information from long-term episodic memory when processing novel metaphors (Cavanna and Trimble 2006). As a matter of fact, the precuneus is responsible for a wide range of cognitive functions such as visuo-spatial imagery, episodic memory retrieval and self-processing. Gibbs, (2006) suggested that imagining appropriate body actions facilitates processing, which is likely due to the activation of relevant pre-motor and motor cortex regions during mental imagery of the relevant actions. It seems that both hemispheres contribute in different degrees to metaphor comprehension.

4. *Conclusions*

In conclusion, metaphor comprehension is a complicated process deeply influenced by cognitive, linguistic and extra-linguistic factors. Each of these factors influences the way an individual processes a simple or complex metaphoric sentence having a salient or non-salient meaning. Analogical reasoning is thought to determine the comprehension of metaphors in the form “A is B” and may involve different cognitive abilities. Unfortunately, it is quite impossible to establish a precise correspondence between brain areas and metaphor processing because most neuropragmatic studies are heterogeneous in terms of linguistic stimuli, task demands, the techniques used and the situational context. Moreover, neuropragmatic studies have left many metaphor types such as the conflation ones out of the picture. This kind of metaphor (e.g., primary ones linked with subjective emotional states – such as love, affection etc.) may, in fact, provide a useful tool for further research since they link the judgemental and emotional parts of our brain with the experiential one. Thus, a more rigorous approach to neuropragmatic experiments is necessary including helpful cooperation between linguists and neurologists in order to build up homogeneous linguistic stimuli and situational context.

Brain mapping of human cognition has few facts to guide the formation of hypotheses because of its complicated and multiple neural interconnections. Consequently, new studies on metaphor comprehension should be designed, concentrating on the role of the different basic cognitive abilities involved in the process. Further research on this topic should provide new insights for other scientific domains such as L2 learning/teaching in optimizing L2 learning processes (in specialized and non-specialized discourse) as well as in Translation Studies simplifying accurate translation. As far as L2 learning/teaching is concerned, the Cognitive Model, as already observed by Ruiz de Mendoza (2008), offers a powerful analytical tool, which besides being sensitive to neurobiological and psychological validation, may allow L2 learners to systematically capture internal and external language similarities and differences where the two languages differ considerably since this view helps us to understand how domains are set up mentally and to what extent that relation is grounded in our bodily nature. Pedagogical applications may also extend to L2 learning/teaching in specialized discourse such as economics as already observed by Charteris-Black and Ennis (2001). The authors suggest that a better understanding of the similarities and differences in metaphor use between source and target language may lead to better understanding on the part of students as well as a better L2 writing.

With regard to Translation Studies, as already observed by Schaeffner (2004), an analysis of the cognitive processes in the translator's mind during a translation act could test whether translators (as text receivers and interpreters) "access conceptual metaphors when constructing interpretations of metaphorical expressions and how this might influence the decision-making for the target text" (2004: 1258). Finally, new neuropragmatic studies should concentrate on investigating the close relationship between mirror neurons and metaphor understanding since the mirror circuits provide a natural substrate for the embodiment of language via image schemata. The recent discovery of mirror neurons (Di Pellegrino *et al.* 1996; Gallese *et al.* 1996; Rizzolati and Arbit 1998) has, in fact, provided new insights into the study of the role of the motor system in language reception, processing and comprehension, suggesting a close association between gesture and metaphor comprehension (Corballis 2010).

REFERENCES

Arzouan Y., A. Goldstein and M. Faust, 2007, "Dynamics of Hemispheric Activity During Metaphor Comprehension: Electrophysiological Measures", *NeuroImage* 36, pp. 222-231.

Baddley A., 2003, "Working Memory: Looking Back and Looking Forward", *Nature Review. Neuroscience* 4(10), pp. 829-839.

Bambini V., 2010, "Neuropragmatics: A Foreword", *Italian Journal of Linguistics* 22(1), pp. 1-20.

Beeman M., 1998, "Coarse Semantic Coding", in M. Beeman and C. Chiarello (eds), *Right Hemisphere Language Comprehension*, Lawrence Erlbaum Associates, Mahwah, NJ, pp. 255-284.

Bertucceli Papi M. and A. Baicchi, 2008, "Pragmatica e Semantica", in I. Iamartino (ed.), *Studi Italiani di Linguistica Teorica e Applicata,* Pacini, Pisa, pp. 91-124.

Blasko D., 1999, "Only the Tip of the Iceberg: Who Understands What About Metaphors", *Journal of Pragmatics* 31, pp. 1675-1683.

Blasko D. and M.C. Connine, 1993, "Effects of Familiarity and Aptness on Metaphor Processing", *Journal of Experimental Psychology: Learning, Memory and Cognition* 19, pp. 295-308.

Cavanna A.E. and M.R. Trimble, 2006, "The Precuneus: A Review of Its Functional Anatomy and Behavioural Correlates", *Brain* 129(3), pp. 564-583.

Charteris-Black J. and T. Ennis, 2001, "A Comparative Study of Metaphor in Spanish and English Financial Writing", *English for Specific Purposes* 20, pp. 249-166.

Chiappe D.L. and P. Chiappe, 2007, "The Role of Working Memory in Metaphor Production and Comprehension", *Journal of Memory and Language* 56, pp. 172-188.

Cohen J.D., WM. Perlstein, T.S. Braver, L.E. Nystrom, D.C. Noll, J. Jonides and E.E. Smith, 1997, "Temporal Dynamics of Brain Activation During Working Memory Task", *Nature* 386, pp. 604-607.

Corballis M.C., 2010, "Mirror Neurons and the Evolution of Language", *Brain and Language* 112, pp. 25-35.

Cornejo C., F. Simonetti, A. Ibáñez, N. Aldunate, F. Ceric and V. López, 2009, "Gesture and Metaphor Comprehension: Electrophysiological Evidence of Cross-modal Coordination by Audiovisual Stimulation", *Brain and Cognition* 70, pp. 42-52.

Coulson S., 2006, "Metaphor and Conceptual Blending", in K. Brown (ed.), *Encyclopaedia of Language and Linguistics,* 2nd edition, Elsevier, Oxford, vol. 7, pp. 32-39.

Coulson S., 2008, "Metaphor Comprehension and the Brain", in R.W. Gibbs (ed.), *Metaphor and thought*, 3rd edition, Cambridge U.P., Cambridge, pp. 177-194.

Coulson S. and T. Matlock, 2001, "Metaphor and the Space Structuring Model", *Metaphor & Symbol* 16(3), pp. 295-316.

Coulson S. and T. Oakley, 2005, "Blending and Coded Meaning: Literal and Figurative Meaning in Cognitive Semantics", *Journal of Pragmatics* 37, pp. 1510-1536.

Damasio H., T.J. Grabowski, D. Tranel, R. Hichwa and A.R. Damasio, 1996, "A Neural Basis for Lexical Retrieval", *Nature* 380, pp. 499-505.

Di Pellegrino G., L. Fadiga, V. Gallese and G. Rizzolati, 1992, "Understanding Motor Events: A Neurophysiological Study", *Experimental Brain Research* 91(1), pp. 176-180.

Dirven R. and F.J. Ruiz de Mendoza Ibáñez, 2010, "Looking Back at 30 Years of Cognitive Linguistics", in E. Tabakowska, M. Choiński and L. Wiraszka (eds), *Cognitive Linguistics in Action: From Theory to Application and Back,* Mouton de Gruyter, Berlin-New York, pp. 13-70.

Duthie J.K., M.A. Nippold, J.L. Billow and T.C. Mansfield, 2008, "Mental Imagery of Concrete Proverbs: A Developmental Study of Children, Adolescent and Adults", *Applied Psycholinguistics* 29, pp. 151-173.

Eviatar Z. and M.A. Just, 2006, "Brain Correlates of Discourse Processing: An fMRI Investigation of Irony and Conventional Metaphor Comprehension", *Neuropsychologia* 44(12), pp. 2348-2359.

Fauconnier G. and M. Turner, 1998, "Conceptual Integration Networks", *Cognitive Science* 22(2), pp. 137-187.

Feldman J.A., 2006, *From Molecule to Metaphor*, The MIT Press, Cambridge, MA.

Fernandez-Duque D. and M.L. Johnson, 1999, "'Attention Metaphor': How Metaphors Guide the Cognitive Psychology of Attention", *Cognitive Science* 23(1), pp. 83-116.

Fletcher P.C., C.D. Frith, C. Baker, T. Shallice, R.S. Frackowiak and R.J. Doland, 1995, "The Mind's Eye-precuneus Activation in Memory-related Imagery", *NeuroImage* 2, pp. 195-200.

Gallese V., L. Fadiga, L. Fogassi and G. Rizzolati, 1996, "Action Recognition in the Premotor Cortex", *Brain* 119, pp. 593-609.

Gallese V. and G. Lakoff, 2005, "The Brain's Concepts: The Role of the Sensory-Motor System in Reason and Language", *Cognitive Neuropsychology* 22, pp. 455-479.

Gagnon L., P. Goulet, F. Giroux and Y. Joanette, 2003, "Processing Metaphoric and Non-metaphoric Alternative Meanings of Words after Right-and Left-Hemispheric Lesion", *Brain and Language* 87, pp. 217-226.

Gentner D., 1983, "Structure-Mapping: A Theoretical Framework for Analogy", *Cognitive Science* 7, pp. 155-170.

Gentner D., B.F. Bowdle, P. Wolff and C. Boronat, 2001, "Metaphor is Like Analogy", in D. Gentner, K.J. Holyoak and B.N. Kokinov (eds), *The Analogy of Mind: Perspectives from Cognitive Science*, MIT Press, Cambridge, MA, pp. 199-253.

Gernsbacher M.A. and R. Roberston, 1999, "The Role of Suppression in Figurative Language Comprehension", *Journal of Pragmatics* 31, pp. 1619-1630.

Gibbs R.W., 1992, "Categorization and Metaphor Comprehension", *Psychological Review* 99(3), pp. 572-577.

Gibbs R.W., 2006, "Metaphor Interpretation as Embodied Simulation", *Mind & Language* 21(3), pp. 434-458.

Giora R., 1997, "Understanding Figurative Language: The Graded Salience Hypothesis", *Cognitive Linguistics* 8(3), pp. 183-206.

Glucksberg S., M.S. McGlone and D. Manfredi, 1997, "Property Attribution in Metaphor Comprehension", *Journal of Memory and Language* 36, pp. 50-67.

Grindon C.M., N.Y. Bilenko, E.B. Myers and S.E. Blumstein, 2008, "The Role of the LIFG in Implicit Semantic Competition and Selection: An Event-Related fMRI Study", *Brain Research* 10, pp. 167-178.

Inhoff A.W., S.D. Lima and P.J. Carroll, 1984, "Contextual Effects on Metaphor Comprehension in Reading", *Memory and Cognition* 12(6), pp. 558-567.

Kacinik N.A. and C. Chiarello, 2007, "Understanding Metaphors: Is the Right Hemisphere Uniquely Involved?", *Brain and Language* 100, pp. 188-207.

Kazmerski V.A., D.G. Blasko and B.G. Dessalegn, 2003, "ERP and Behavioural Evidence of Individual Differences in Metaphor Comprehension", *Memory and Cognition* 31(5), pp. 673-689.

Kintsch W., 2000, "Metaphor Comprehension: A Computational Theory", *Psychonomic Bulletin* & *Review* 7, pp. 257-266.

Kircher T.J., D.T. Leube, M. Erb, W. Grodd and A.M. Rapp, 2007, "Neural Correlates of Metaphor Processing in Schizophrenia", *NeuroImage* 34, pp. 281-289.

Kosslyn S., M. Behrmann and M. Jeannerod, 1995, "The Cognitive Neuroscience of Mental Imagery", *Neuropsychologia* 33(11), pp. 1335-1344.

Lakoff G., 1987, *Women, Fire, and Dangerous Things: What Categories Reveal About the Mind,* University of Chicago Press, Chicago.

Lakoff G., 1993, *The Contemporary Theory of Metaphor*, in A. Ortony (ed.), *Metaphor and Thought*, Cambridge U.P., Cambridge.

Lakoff G. and M. Johnson, 1980, "The Metaphorical Structure of the Human Conceptual System", *Cognitive Science* 4, pp. 195-208.

Lakoff G. and M. Johnson, 1999, *Philosophy in the Flesh. The Embodied Mind and Its Challenge to Western Thought*, Basic Books, New York.

Mashal N., M. Faust, T. Hendler and M. Jung-Beeman, 2007, "An fMRI Study of the Neural Correlates Underlying the Processing of Novel Metaphoric Expressions", *Brain and Language* 100, pp. 115-126.

Matlock T., M. Ramscar and L. Boroditsky, 2005, "The Experiential Link between Spatial and Temporal Language", *Cognitive Science* 29, pp. 655-664.

Miller G.A., 1991, "Immagini e modelli, paragoni e metafore", in C. Cacciari (ed.), *Teorie della metafora*, Raffaele Cortina Editore, Milano, pp. 59-123.

McGlone M.S., 1996, "Conceptual Metaphors and Figurative Language Interpretation: Food or Thought?", *Journal of Memory and Language* 35, pp. 544-565.

Nikolaenko N.N., 2001, "Study of Metaphoric and Associative Thinking in Children of Different Age Groups and in Patients with Childhood Autism", *Journal*

of Evolutionary Biochemistry and Physiology 39(1), pp. 77-83.
Ortony A., 1979, "Beyond Literal Similarity", *Psychological Review* 86, pp. 161-180.
Ortony A., D.L. Schallert, R.E. Reynolds and S.J. Antos, 1978, "Interpreting Metaphors and Idioms: Some Effects of Context and Comprehension", *Journal of Verbal Learning and Verbal Behavior* 17, pp. 465-477.
Paivio A., 1971, *Imagery and Verbal Processes*, Holt, Rinehart & Winston, New York.
Ramachadran V.S. and E.M. Hubbard, 2003, "Hearing, Colors, Tasting Shapes", *Scientific American* 288(5), pp. 42-49.
Rapp A.M., D.T. Leube, M. Erb, W. Grodd and T.J. Kircher, 2004, "Neural Correlates of Metaphor Processing", *Cognitive Brain Research* 20, pp. 395-402.
Rizzolati G. and M. Arbit, 1998, "Language within Our Grasp", *Trends in Neurosciences* 21, pp. 188-194.
Rohrer T., 2005, "Image Schemata in the Brain", in B. Hampe and J. Grady (eds), *From Perception to Meaning: Image Schemas in Cognitive Linguistics*, Mouton de Gruyter, Berlin, pp. 165-196.
Ruiz de Mendoza Ibáñez, F.J. and J.L. Otal, 2002, *Metonymy, Grammar, and Communication*, Comares, Granada.
Ruiz de Mendoza Ibáñez F.J. and F. Santibáñez Sáenz, 2003, "Content and Formal Cognitive Operations in Constructing Meaning", *Rivista di Linguistica* 15(2), pp. 293-320.
Ruiz de Mendoza Ibáñez F.J., 2008, "Cross-linguistic Analysis, Second Language Teaching and Cognitive Semantics: The Case of Spanish Diminutives and Reflexives Constructions", in S. De Knop and T. De Rycher (eds), *Cognitive Approaches to Pedagogical Grammar – Volume in Honor of René Dirven,* Mouton de Gruyter, Berlin-New York, pp. 121-152.
Schaeffner C., 2004, "Metaphor and Translation: Some Implications of a Cognitive Approach", *Journal of Pragmatics* 36, pp. 1253-1269.
Smith K.A., 2008, "Restructuring Metaphors: Using Mental Re-mapping in Cognitive Coaching", *Journal of Rational-Emotional Cognitive Behavioural Therapy* 26, pp. 16-29.
Soroker N., A. Kasher, R. Giora, G. Batori, C. Corn, M. Gil and E. Zaidel, 2005, "Processing of Basic Speech Acts Following Localized Brain Damage: A New Light on the Neuroanatomy of Language", *Brain and Cognition* 57, pp. 214-217.
Stemmer B., 2000, "Neuropragmatics in the 21st Century", *Brain and Language* 1, pp. 233-236.
Trick L. and A.N. Katz, 1996, "The Domain Interaction Approach to Metaphor Processing: Relating Individual Differences and Metaphor Characteristics", *Metaphor and Symbolic activity* 1, pp. 185-213.
Wilson D. and D. Sperber, 2004, "Relevance Theory", in L. Horn and G. Ward (eds), *Handbook of Pragmatics,* Blackwell, Oxford, pp. 607-632.
Wilson D. and R. Carston, 2006, "Metaphor, Relevance and the 'Emergent Property' Issue", *Mind and Language* 21(3), pp. 404-433.

Yang F.G., J. Edens, C. Simpson and D. Krawczyk , 2009, "Differences in Task Demands Influence the Hemispheric Lateralization and Neural Correlates of Metaphor", *Brain and Language* 111, pp. 114-124.

Yang F.G., J. Fuller, N. Khodaparast and D.C. Krawczyk, 2010, "Figurative Language Processing after Traumatic Brain Injury in Adults: A Preliminary Study", *Neuropsychologia* 48, pp. 1923-1929.